

Knee pain and associated complications after intramedullary nailing of tibial shaft fracture

Nikolaj Erin-Madsen¹, Tobias Kvanner Aasvang², Bjarke Viberg³, Thomas Bloch⁴, Michael Brix⁵ & Peter Toft Tengberg¹

ABSTRACT

INTRODUCTION: The treatment of choice for unstable diaphyseal fractures in the tibia is reamed insertion of an intramedullary nail (IMN). The most common complication to this treatment is chronic knee pain with reported rates ranging from 10% to 87% with a mean of 47.4% in meta-analyses.

METHODS: This study evaluates the long-term outcome after IMN insertion in adult patients with a tibial shaft fracture using the Knee Injury and Osteoarthritis Outcome Score (KOOS) questionnaire. The study includes patients operated on one of five Danish hospitals in a five-year period. The patients received a KOOS questionnaire with questions regarding knee-specific symptoms, stiffness, pain, function and quality of life. Data were subsequently compared to those of a reference population.

RESULTS: A total of 391 patients were enrolled from the trauma centre's database search. 55 patients did not meet the inclusion criteria. Questionnaires were sent out to 336 patients and 223 (66%) responded. Mean age was 47.9 years at the time of surgery; 63% were men. The follow-up time ranged from 1.7 to 6.7 years.

CONCLUSIONS: With a follow-up time of more than six years after receiving an IMN, patients in this study experienced more knee-specific symptoms, pain, limitations in sports and daily living than a reference population who had not undergone surgery. The study population also reported poorer quality of life outcomes than the reference population.

FUNDING: none.

TRIAL REGISTRATION: Approved by the Danish Data Protection Agency. Clinical trials: NCT03649360.

Tibial shaft fractures are the most common long bone fracture worldwide, with an annual incidence of 26 per 100,000 [1]. Intramedullary nailing (IMN) locked with anti-rotation screws is the first-choice treatment of displaced tibial shaft fractures in adults [2]. The method is not without complications, though. Chronic anterior knee pain at the insertion site is among the most frequently reported complications with an incidence ranging from 10% to 87% and a mean incidence of 47.4% in meta-analysis [3]. The cause of such pain remains unknown, but is believed to be multifactorial, with proposed causes being the surgical approach in relation to

the patella tendon [4], placement of the incision site [5], violation of Hoffa's fat pad [6], violation of intra-articular structures [7], nail prominence [8], nail diameter [9] and atrophy of thigh musculature [10]. Studies have also suggested that patients have a significant rate of both subjective and objective complications, where restrictions in quality of life and limitations in sports have been reported [11].

In this study, we conducted a retrospective analysis of patients who had undergone surgery with the insertion of an IMN after tibial shaft fracture. The aim of this study was to evaluate the long-term frequency of knee pain and associated complications after treatment with IMN.

METHODS

We conducted a retrospective multicentre study with the orthopaedic departments at the following five Danish hospitals: Hvidovre Hospital, Herlev Hospital, Slagelse Hospital, Odense University Hospital and Kolding Hospital. Doctors specialised in orthopaedic surgery or attending such surgery were assigned to manage a patient-charting database search at each hospital, using the local charting database. Data including social security number, time of surgery and address were obtained. All patients who underwent surgery with reamed, locked IMN after isolated tibial shaft fracture at one of the above-mentioned orthopaedic departments between 1 November 2009 and 30 October 2014 were sought. Patients aged 18 years or older, alive and residing in Denmark at the time of follow-up were included in the study. Patient characteristics are presented in **Table 1**. We excluded patients who were unable to fill out the questionnaire due to concomitant physical conditions or who had undergone amputation or further surgery on the affected limb.

This was a cross-sectional cohort study where data were collected by sending out invitations and Knee Injury and Osteoarthritis Outcome Score (KOOS) questionnaires by mail to each of the patients matching the inclusion criteria. Non-responders received another letter as a reminder to the first invitation.

The study was approved by the Danish Data Protection Agency and registered with clinicaltrials.gov with registration number: NCT03649360.

ORIGINAL ARTICLE

- 1) Department of Orthopaedic Surgery, Herlev and Gentofte Hospital
- 2) Department of Orthopaedic Surgery, Hvidovre Hospital
- 3) Department of Orthopaedic Surgery, Kolding Hospital
- 4) Department of Orthopaedic Surgery, Slagelse Hospital
- 5) Department of Orthopaedic Surgery, Odense University Hospital, Denmark

Dan Med J
2019;66(8):A5554

The Knee Injury and Osteoarthritis Outcome Score questionnaire

We chose the KOOS questionnaire [12] for collection of patient data as it is patient-administered, the format is user friendly and it takes only about ten minutes to complete. Furthermore, it is self-explanatory and can be used as a postal survey. The questionnaire is used to assess the patient's subjective opinion about symptoms related to the knee and other associated problems. It is designed for patients who have experienced knee injury including meniscal injury, anterior cruciate ligament injury, tibial plateau fracture, total knee replacement and osteochondral lesions that can result in post-traumatic osteoarthritis. The questionnaire has been translated and validated in Danish and consists of five subscales: pain, symptoms, function in daily living (ADL) function in sports and recreation, and knee-related quality of life (QoL). Each subscale has between four and 17 questions (a total of 42 questions) with each question having five response options ranging from no symptoms to severe symptoms. Each question is scored from zero to four, and a score from 0-100 is calculated: 100 indicating no symptoms and 0 indicating major symptoms.

Statistical analysis

Sample size estimation was based on an independent unequally sized two-sample t-test for the KOOS pain score between the reference population and the study group. The minimal clinically relevant difference was 6.0 points for pain, 5.0 points for symptoms, 7.0 points for ADL, 5.8 for sports and recreation and 7.0 points for QoL – set in line with the KOOS recommendations [13]. Power was set to 90% and a significance level of $p = 0.05$ was chosen. The standard deviation (SD) was

estimated from the pooled variance using the SD from a similar study population and the SD calculated from the KOOS confidence interval (CI) of the reference population of 533, estimating a SD of 29.3, giving a study sample size of 109. Expected dropout from non-responding was set to 40%, corresponding to a minimum of 182 patients needed.

We defined four different age groups (18-34, 35-54, 55-74 and 75-99 years) to compare age- and gender-related differences.

Data were then collected, analysed and compared with a KOOS reference population [14]. Reference data have been published in a general population-based sample made in Southern Sweden for 840 subjects aged 18-84 years. The population was divided into four similar age groups (18-34, 35-54, 55-74, 75-99 years). This study used the same age groups for data analysis. The population did not undergo any kind of surgery before filling out the KOOS questionnaire.

Trial registration: The study was approved by the Danish Data Protection Agency. Clinical trials registration: NCT03649360.

RESULTS

A total of 391 patients were enrolled from the search. In all, 31 patients had either emigrated or had concomitant disorders that made them ineligible for study participation. A total of 24 patients had died. Invitations and questionnaires were sent out to 336 patients, and of these 113 did not return the questionnaire producing a final cohort of 223 patients (66% response rate) (**Figure 1**).

The mean age at the time of fracture was 47.9 years (31.6-64.2) and the mean age at follow-up was 52.1 (35.8-68.4). Time from operation to follow-up ranged from 1.7 to 6.7 years (4.2) (Table 1).

Patients in this study generally reported more serious KOOS scores than the reference population on all five subscales (**Table 2**). A comparison of the reference population showed that the age group of 18-34-year-olds reported the most serious difficulties. For the subgroups of pain, ADL, and especially, function in sports and recreation and QoL, they reported more difficulties when mean scores were compared with the reference group (**Figure 2**). When asked to indicate which degree of difficulty they had experienced while kneeling in the past week, 76.9% in the female group and 75% in the male group answered either "severe" or "extreme". 66.7% in the male group reported the same degree of difficulty when asked about running and 62.5% when asked about jumping. 66.7% in the male group answered "daily" or "constantly" when asked how often they were made aware of their knee problem. A similar pattern was seen in the female 35-54-year-old popula-

TABLE 1

Characteristics of the 223 patients.

	Male	Female	Total
<i>Patients, n (%)</i>			
Hvidovre Hospital	44	22	66
Herlev Hospital	14	18	32
Slagelse Hospital	16	9	25
Odense University Hospital	46	23	69
Kolding Hospital	21	10	31
Total	141 (63.2)	82 (36.8)	223
<i>Age, mean ± SD, yrs</i>			
At surgery	47.9 ± 16.3	49.6 ± 16.4	-
At follow-up	-	-	52.1 ± 16.3
Time from surgery to follow-up, yrs	-	-	4.2 ± 1.4

SD = standard deviation.

tion, where 59.3% reported the same degree of difficulties. In comparison, only 32.6% of the men in the 55-74-year group reported the same severity of symptoms.

In the 35-54-year-old population, women reported a statistically significantly poorer outcome than the reference population in all subgroups (Figure 2). 48% answered either "totally" or "severely" when asked whether they had modified their lifestyle to avoid potentially damaging activities to the knee.

The 75-99-year-old population had 17 patients with only six in the female group, which made it insufficient for statistical analyses.

DISCUSSION

The exact cause of anterior knee pain after IMN remains unknown. The reason is thought to be multifactorial, and several proposed causes have been investigated. Whether exact causative factors arise from the injury or the operation has not been clarified. Skoog et al [15] have compared high- and low-energy injuries and reported significantly poorer outcomes for patients with tibial fracture after high-energy trauma. Katsoulis et al [3] suggested inter-operative traumas as a possible cause of long-term complications.

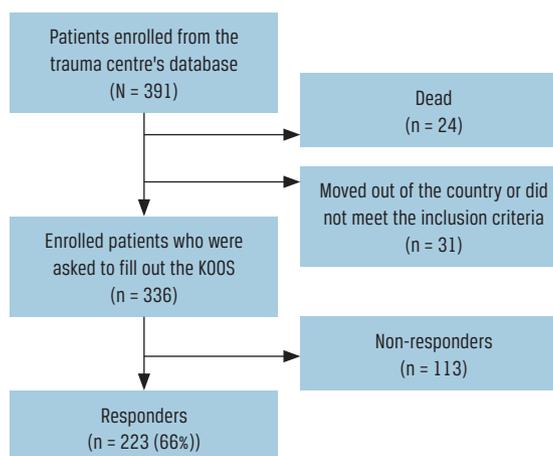
One cause that has been discussed in various papers is whether the transtendinous approach is more related to post-operative knee pain than the paratendinous approach. Court-Brown et al [16] documented no association between these two surgical approaches and anterior knee pain, although Keating et al [17] found a clear association between the transtendinous surgical approach and chronic anterior knee pain.

In this study, the 18-34-year-old group reported the most serious symptoms when compared to the reference population. In the subscale "Sports and Recreation", women and men reported a mean KOOS score of 39.29 and 40.21, respectively. In comparison, the reference population that did not undergo any surgery, reported significantly higher KOOS scores with calculated CI of 81.5-91.3 for women and 79.7-90.5 for men. 76.9% in the female group and 75% in the male group answered either "severe" or "extreme" when asked to indicate the degree of difficulty they had experienced while kneeling in the past week. 66.7% in the male group reported the same degree of difficulty when asked about running and 62.5% when asked about jumping. On the "Quality of Life" subscale, the reported mean was 55.4 and 48.2 for women and men, respectively, with the confidence interval for reference population being 78.9-88.3 and 80.3-90.3, respectively. A reason for this trend might be that the younger patients are more active and therefore have higher demands for post-operative mobilisation.

In the 18-34-year-old group, 66.7% of the men reported "daily" or "constantly" when asked how often

FIGURE 1

Flow chart of patient enrolment in the study.



KOOS = Knee Injury and Osteoarthritis Outcome Score.

they were made aware of their knee problem; 32.6% of the men in the 55-74-year-old population reported the same. This may also indicate a higher level of expectations in the younger groups.

A similar pattern with symptoms being more serious in younger patients was found by Larsen et al [11]. This study also used the KOOS questionnaire to compare patients treated with IMN to a reference population with a mean of follow-up of 7.9 years. The study group in this study reported a 44% higher incidence of knee pain, a 39% higher incidence of function in daily living limitations, a 58% higher incidence of limitations in quality of life and a 60% higher incidence of limitations during sports activities. Similar to this study, the group of 18-34-year-olds reported the most severe difficulties.

Court-Brown et al [16] also reported that younger patients experienced more severe knee pain. In a retrospective study with 169 patients treated with IMN after tibia shaft fracture, 56.2% reported anterior knee pain, with 91.8% experiencing pain on kneeling and 33.7% having pain even at rest. They did not, however, find differences related to gender where this study in general reported more severe symptoms experienced by women than by men. Vaistö et al [10] also reported that women were more symptomatic than men and had a longer hospital stay after tibial nailing. One explanation for the variation in knee pain seen with gender is the prevalence of widespread pain. Widespread pain is related to age with an increase in patients over 50 years of age [18], and one study described that long-standing knee pain in women was more frequently part of a widespread pain syndrome than knee pain in men (68% versus 40%) [19]. We used the KOOS questionnaire as it has been described as a reliable and respon-

sive tool for assessment of knee complaints [20]. One limitation associated with using this questionnaire is that it does not include data on knee disease or general health status prior to the injury, making it difficult to

precisely analyse the variations seen. A possible addition to a future study may be the assessment of patient's total body pain to separate patients with widespread pain from those with knee pain only.

TABLE 2

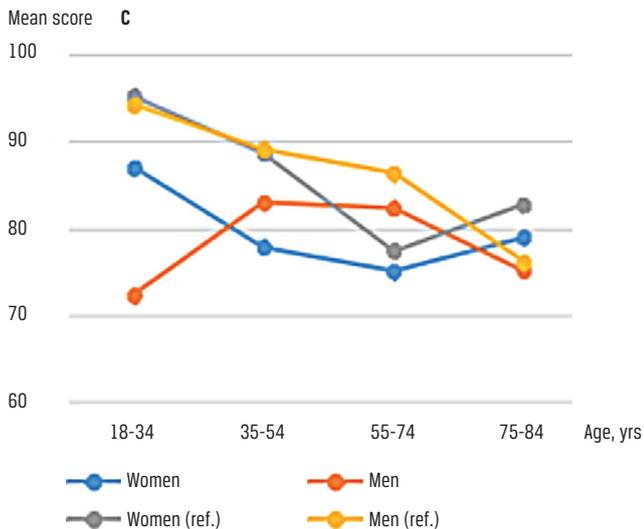
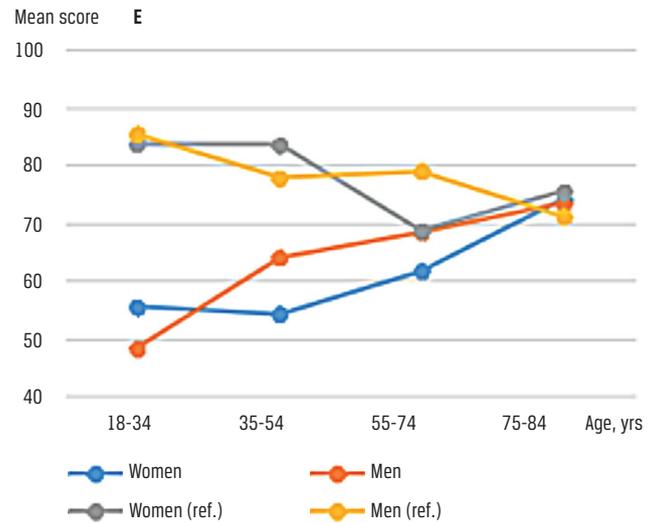
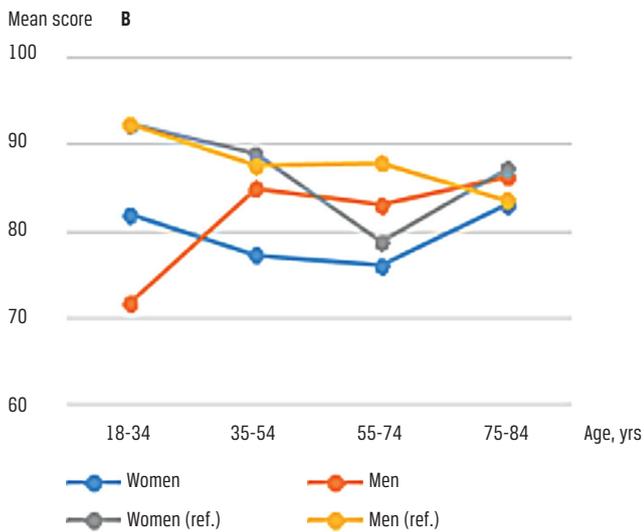
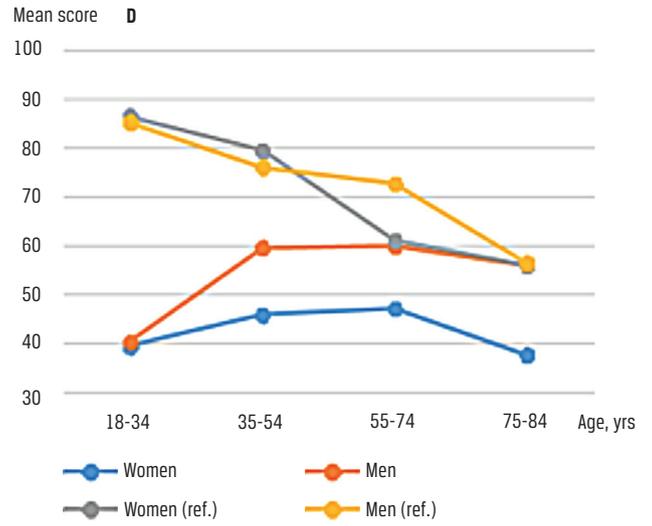
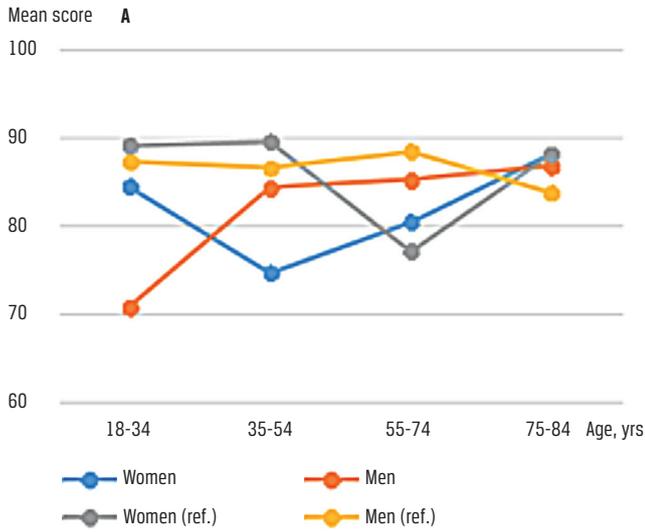
Age and gender characteristics.

	KOOS				
	symptoms	pain	ADL	sports and recreation	QoL
18-34 yrs					
Women					
n	14	14	14	14	14
95% CI:					
Score	77,8-91,0	79,5-84,0	84,6-89,3	35,3-43,3	53,9-56,9
Reference	86,0-92,2	88,8-95,3	92,5-97,8	81,5-91,3	78,9-88,3
Men					
n	24	24	24	24	24
95% CI:					
Score	67,2-74,2	69,0-74,1	70,8-73,7	36,3-44,1	46,1-50,3
Reference	83,6-90,8	89,8-95,6	91,6-96,7	79,7-90,5	80,3-90,3
35-54 yrs					
Women					
n	27	27	27	27	27
95% CI:					
Score	72,4-76,8	75,6-78,7	75,9-79,7	43,4-48,1	51,4-57,0
Reference	86,2-92,7	84,6-93,0	84,2-92,9	73,1-85,4	78,5-88,3
Men					
n	56	56	56	56	56
95% CI:					
Score	82,14-86,36	83,11-86,43	81,91-83,95	56,67-62,28	61,76-66,14
Reference	82,7-90,2	83,4-91,5	85,1-93,1	69,2-82,7	72,0-83,5
55-74 yrs					
Women					
n	35	35	35	35	35
95% CI:					
Score	78,65-82,17	74,37-77,37	73,42-76,58	44,95-49,05	59,84-63,38
Reference	71,7-82,4	73,1-84,1	78,8-83,1	53,0-69,0	61,8-75,4
Men					
n	49	49	49	49	49
95% CI:					
Score	85,1-86,4	81,5-84,2	81,0-83,6	57,8-61,8	67,0-69,75
Reference	84,8-92,1	84,0-91,4	82,3-90,3	66,2-78,9	73,5-84,3
75-99 yrs					
Women					
n	6	6	6	6	6
95% CI:					
Score	85,7-90,5	81,7-84,0	76,8-80,9	34,2-40,8	73,0-74,9
Reference	83,1-93,0	80,6-93,5	75,9-89,6	42,9-68,9	65,9-85,0
Men					
n	11	11	11	11	11
95% CI:					
Score	85,32-88,05	84,58-87,64	73,53-76,73	53,5-58,28	71,5-75,1
Reference	77,3-90,1	75,91,6	67,7-84,5	44,4-68,3	61,1-81,1

ADL = activity in daily living; CI = confidence interval; KOOS = Knee Injury and Osteoarthritis Outcome Score; QoL = quality of life.

FIGURE 2

Age- and gender-specific Knee Injury and Osteoarthritis Outcome score given as the mean for the patients and the mean for the reference group. **A.** Symptoms. **B.** Pain. **C.** Activity in daily living. **D.** Sports and recreation. **E.** quality of life.



The limitations of this study are its retrospective design with patients being enrolled via a database search and then conducting a cross sectional study by using the KOOS questionnaire. Whether the patients' symptoms were more severe or the same before filling out the questionnaire was not investigated. Some of the strengths to this study are the high 66% response rate with a follow-up of up to nearly seven years, the large number of patients enrolled and, finally, the existence of a KOOS reference population.

CONCLUSIONS

Knee pain, swelling and stiffness, restrictions in quality of life and limitations in sports remain common complications after operation with the insertion of an intramedullary nail after tibia shaft fracture. When compared to a reference population, younger patients and women in general reported more difficulties. After a follow-up period of up to nearly seven years, the primary limitations were reported on "Sports and Recreation" and "Quality of Life". Among the 18-34-year-olds in the "Sport and Recreation" group, 76.9% of the women and 75% of the men indicated that they had either experienced "severe" or "extreme" difficulty while kneeling in the past week.

CORRESPONDENCE: Nikolaj Erin-Madsen.
E-mail: nikolajerin-madsen@hotmail.com

ACCEPTED: 16 May 2019

CONFLICTS OF INTEREST: none. Disclosure forms provided by the authors are available with the full text of this article at Ugeskriftet.dk/dmj

LITERATURE

1. Court-Brown CM, McBurnie J. The epidemiology of tibial fractures. *J Bone Joint Surg Br* 1995;77:417-21.
2. Alho A, Ekeland A, Stromsoe K et al. Locked intramedullary nailing for displaced tibial shaft fractures. *J Bone Joint Surg Br* 1990;72-B:805-9.
3. Katsoulis E, Court-Brown CM et al. Incidence and aetiology of anterior knee pain after intramedullary nailing of the femur and tibia. *J Bone Joint Surg Br* 2006;88:576-80.
4. Toivanen JA, Vaisto O, Kannus P et al. Anterior knee pain after intramedullary nailing of fractures of the tibial shaft: A prospective, randomized study comparing two different nail-insertion techniques. *J Bone Joint Surg Am* 2002;84-A:580-5.
5. Althausen PL, Neiman R, Finkemeier CG. Incision placement for intramedullary tibial nailing: an anatomic study. *J Orthop Trauma* 2002;16:687-90.
6. Weninger P, Schultz A, Traxler H et al. Anatomical assessment of the Hoffa fat pad during insertion of a tibial intramedullary nail: comparison of three surgical approaches. *J Trauma* 2009;66:1140-5.
7. Hernigou P, Cohen D. Proximal entry for intramedullary nailing of the tibia. The risk of unrecognized articular damage. *J Bone Joint Surg Br* 2000;82:33-41.
8. Bhattacharyya T, Seng K, Nassif NA et al. Knee pain after tibial nailing: the role of nail prominence. *Clin Orthop Relat Res* 2006;449:303-7.
9. Karachalios T, Babis G, Tsarouchas J et al. The clinical performance of a small diameter tibial nailing system with a mechanical distal aiming device. *Injury* 2000;31:451-9.
10. Vaistö O, Toivanen JA, Kannus P et al. Anterior knee pain and thigh muscle strength after intramedullary nailing of a tibial shaft fracture: an 8-year follow-up of 28 consecutive cases. *J Orthop Trauma* 2007;21:165-71.
11. Larsen P, Lund H, Laessoe U et al. Restrictions in quality of life after intramedullary nailing of tibial shaft fracture: a retrospective follow-up study of 223 cases. *J Orthop Trauma* 2014;28:507-12.
12. KOOS questionnaire. www.koos.nu (2 Oct 2017).
13. Collins NJ, Misra D, Felson DT et al. Measures of knee function: International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form, Knee Injury and Osteoarthritis Outcome Score (KOOS), Knee Injury and Osteoarthritis Outcome Score Physical Function Short Form (KOOS-PS), Knee Outcome Survey Activities of Daily Living Scale (KOS-ADL), Lysholm Knee Scoring Scale, Oxford Knee Score (OKS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Activity Rating Scale (ARS), and Tegner Activity Score (TAS). *Arth Care Res* 2011;63(suppl 11):S208-S228.
14. Paradowski PT, Bergman S, Sundén-Lundius A et al. Knee complaints vary with age and gender in the adult population. Population-based reference data for the knee injury and osteoarthritis outcome score (KOOS). *BMC Musculoskeletal Disord* 2006;7:38.
15. Skoog A, Soderqvist A, Tornqvist H et al. One-year outcome after tibial shaft fractures: results of a prospective fracture registry. *J Orthop Trauma* 2001;15:210-5.
16. Court-Brown CM, Gustilo T, Shaw AD. Knee pain after intramedullary nailing: its incidence, etiology, and outcome. *J Orthop Trauma* 1997;11:103-5.
17. Keating JF, Orfaly R, O'Brien PJ. Knee pain after tibial nailing. *J Orthop Trauma* 1997;11:10-3.
18. Thomas E, Peat G, Harris L et al. The prevalence of pain and pain interference in a general population of older adults: cross-sectional findings from the North Staffordshire Osteoarthritis Project (NorSTOP). *Pain* 2004;110:261-8.
19. Bergman S, Herrstrom P, Hogstrom K et al. Chronic musculoskeletal pain, prevalence rates, and sociodemographic associations in a Swedish population study. *J Rheumatol* 2001;28:1369-77.
20. Garratt AM, Breasley S, Gillespie WJ. Patient-assessed health instruments for the knee: a structured review. *Rheumatology (Oxford)* 2004;43:1414-23.